AIR QUALITY

NORTHWESTERN ONTARIO

Annual Report, 1985

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SUMMARY

This report presents results of the Ministry's air quality assessment program in northwestern Ontario for 1985. It includes data from 11 communities where long-term monitoring is conducted, plus summaries of special studies in the Thunder Bay area.

ATIKOKAN

Pre-operational sampling was completed around Ontario Hydro's power plant at Atikokan. Residual arsenic and iron contamination was confirmed in vegetation and soil around formerly active iron ore mines near the generating station.

Suspended particulate matter, monitored at the Atikokan Weather Station, continued to be recorded at satisfactory levels.

BALMERTOWN

Arsenic persisted at elevated concentrations in vegetation on company property near two gold mines, but was near normal in the adjoining townsite. Except for one sample with slightly elevated arsenic, all vegetable samples from residential gardens met guidelines for arsenic and mercury.

In 1985, there were 114 hourly sulphur dioxide readings above the maximum acceptable limit, compared with 50 such occurrences in 1984. There were about 4 hectares of vegetation injured by sulphur dioxide, mostly on company property. To avoid significant vegetation damage in future, Campbell Red Lake Mines Limited has been asked to improve the effectiveness of its sulphur dioxide abatement program during the growing season.

DRYDEN

Concentration of all identified pollutants met Ministry regulations off company property around a new secondary treatment system (lagoon) operated by Great Lakes Forest Products Limited. No disease-causing bacteria of domestic waste origin were present in liquid from the lagoon. The company's continuing abatement program to minimize off-property fallout of foam particles and spray drift will be closely monitored by the Ministry.

Odour levels, caused by total reduced sulphur (TRS) from a kraft pulp mill, declined in the town centre in 1985, continuing the trend started in 1982. There were only 17 exceedences of the TRS guideline during the year.

FORT FRANCES

There was no new vegetation injury recorded near the Fort Frances kraft pulp mill in 1985.

Levels of dustfall and suspended particulate matter were about the same as preceding years. Emissions of wood fines and saltcake from mill operations sometimes contributed significantly to dustfall readings above the provincial objective.

TRS concentrations declined in 1985, compared to 1984. Despite this improvement, the provincial guideline for TRS was still frequently exceeded.

The company and the Ministry will closely monitor mill operations to minimize upset conditions which could lead to excessive odour and particulate emissions. These emissions, plus other issues, will be addressed in a new Control Order to be developed by the end of 1986.

KENORA

No vegetation damage complaints were received in 1985. Dustfall sometimes exceeded Ontario objectives because of flyash, wood or bark char, and road dust. Particulate matter emissions from the local sulphite pulp mill must meet Ministry regulations by 1988.

Sulphur dioxide met all provincial air quality objectives.

LONGLAC

Although there were some moderately elevated dustfall readings, average levels were lower than those in 1984. Over 90 percent of the samples of suspended particulate matter met the air quality objective, and the annual average was also acceptable.

MARATHON

Average airborne sulphur levels have shown little change during recent years. However, concentrations of reduced sulphur exceeded the provinical guideline on 52 occasions at the Ministry's monitoring station in the townsite, compared with 22 exceedences in 1984. A modernization program at the local pulp mill is expected to result in decreased emissions of reduced sulphur during the next two or three years. Sulphur dioxide concentrations were satisfactory.

The Ministry and mill management are also investigating solutions to a localized problem of wind-blown wood fibres from wood-chip storage piles.

RED ROCK

Average dustfall in the townsite declined about 20 percent from 1984 to 1985. Dustfall met the provincial objective about 70 percent of the time at the three off-property monitoring sites near the Domtar mill. Under a new Control Order, an emission inventory report to assess the need and feasibility of further controls on particulate matter will be submitted by the company to the Ministry in 1987.

Odour levels increased from 1984 to 1985, with 117 exceedences of the TRS guideline. Operating problems at the mill which led to this increase have been resolved or are under investigation. The new Control Order requires compliance with the TRS guideline by the end of 1988.

TERRACE BAY

Total reduced sulphur was above the Ontario guideline in Terrace Bay for 60 hours in 1985 because of emissions from the Kimberly-Clark kraft pulp mill. The company is investigating options to reduce its emissions of TRS. Compliance with the guideline will be a requirement in the next Control Order, due in 1987.

THUNDER BAY

Average dustfall in Thunder Bay in 1985 was within the acceptable range and has been essentially unchanged for several years. Dustfall near Great Lakes Forest Products declined from 1984 to 1985, reflecting a reduction in emissions from the company's power boilers.

Average suspended particulate matter in the air was satisfactory during the year. Over 99 percent of the samples met the 24-hour Ontario air quality objective. Except for five days during the year, soiling index levels were also acceptable.

For all but two hours at one site, full compliance was achieved for all air quality objectives for sulphur dioxide. Total reduced sulphur (TRS) levels, at the Ministry's single monitoring site near Great Lakes Forest Products Limited, met the TRS guideline throughout the year.

Ozone, a pollutant usually associated with long-range transport, met the Ontario air quality objective at all times.

INTRODUCTION

PURPOSE OF MONITORING PROGRAM

The Ontario Ministry of the Environment conducts an air quality assessment program throughout the province. This program monitors, in outdoor air, the levels of pollutants that may adversely affect human health, animal life, vegetation, and the use and enjoyment of property. These surveys record compliance with air quality objectives, and determine long-term air quality trends. The monitoring program identifies pollution sources and assesses the results of pollution control measures.

In northwestern Ontario, air quality surveys first began in 1963 to measure airborne dust in the City of Thunder Bay. By 1985, the program had expanded to include nine pollutants monitored by more than 100 instruments in 11 urban centres. Ontario Hydro also has air quality networks in Thunder Bay and Atikokan. Data from air quality instruments are supplemented by vegetation, soil and snow sampling studies, and by predictions of pollutant levels with mathematical models.

Monitoring in the region is mostly conducted in urban areas and near industrial sources of air pollution (eg. mining, pulp and paper). Therefore, air quality problems described in this report are not typical of the region, where air quality is generally excellent.

Acid rain is a major environmental issue in eastern North America and in parts of Europe. Ontario, through its Acidic Precipitation in Ontario Study, is assessing the effects of acid fallout and is developing possible answers to this problem. The Ministry's Northwestern Region participates in this program through precipitation sampling surveys at 12 sites and through research on the aquatic and terrestrial effects of acid rain. The findings of these studies are reported elsewhere.

A major new development in the air quality program in northwestern Ontario is the installation of a telemetry system to

improve the quality of data and to greatly increase the speed with which data are received. This system is expected to be in place by the summer of 1986. It will permit the Ministry to obtain immediate readings from any continuous monitor in the region. When telemetry is in place, a daily Air Quality Index (AQI) will be published for Thunder Bay. The AQI will be based on readings for five pollutants: sulphur dioxide, ozone, carbon monoxide, nitrogen dioxide, and total reduced sulphur. As resources permit, the publication of an AQI may be extended to other communities in the region.

POLLUTANTS AND THEIR MEASUREMENT

Under this heading, only those contaminants routinely monitored in northwestern Ontario are considered. Carbon monoxide and hydrocarbons are not presently measured, nor are exotic organic compounds. If the need arises, many of the more unusual pollutants can be monitored with mobile equipment from the Ministry's Air Resources Branch, Toronto.

Particulate Matter

There are many man-made and natural sources of airborne particulate matter. Typical man-made sources in northwestern Ontario are forest product industries and mining operations. Wind-blown particles from stored materials and roadways are examples of secondary sources. Particulate matter may also be emitted from forest fires, volcanoes, and dust storms. Depending on particle size and chemical makeup, particulate matter may be harmful to health and vegetation, may adversely affect visibility, and may cause local nuisance problems. In Ontario, particulate matter is measured as dustfall, total suspended particulate matter (TSP), or soiling index.

Dustfall is particulate matter that settles out from the air by gravity. Open-top containers (dustfall jars) are exposed for 30-day periods and the collected matter is weighed.[1] The monthly air quality objective (maximum acceptable limit) for dustfall is

7 $g/m^2/30$ d (grams per square metre during 30 days). The annual objective is 4.6 $g/m^2/30$ d. Dustfall estimates the fallout of particulate matter from local sources, including dust from nearby construction or from vehicular traffic.

Suspended particulate matter comprises particles of small size which remain entrained in the air for long periods. This material may come from local or distant sources. It is measured with a high-volume sampler for a 24-hour period every sixth day.[2] The difference in the weight of a fibreglass filter before and after exposure determines the quantity of particulate matter collected. The air quality objective is 120 $\mu g/m^3$ (micrograms per cubic metre of air) averaged over 24 hours, or 60 $\mu g/m^3$, annual geometric mean.

Soiling index is a measure of the soiling or darkening properties of very small airborne particles and is expressed as coefficient of haze (COH). It is probably closely related to the concentration of respirable particulate matter. A measured volume of air passes through a paper tape which moves through an automated sampling unit to produce a reading every hour. The reduction of light transmitted through the tape is expressed as coefficient of haze (COH) per 1,000 linear feet of air sampled. The Ontario objective is 1.0 COH, 24-hour average, and 0.5 COH, annual average.

Gaseous Pollutants

Sulphur Dioxide

Sulphur dioxide (SO_2) is one of the world's major atmospheric pollutants and has many well-known adverse effects on human health, vegetation and property. It is also one of the main contributors to the formation of acid rain. In northwestern Ontario, the principal SO_2 sources are small compared to those in some other parts of the province. The main regional emitters of SO_2 are, in approximate descending order of importance, the Ontario Hydro generating station in Thunder Bay, sulphite pulp mills, gold ore roasting, and industrial boilers. SO_2 may be

measured with passive samplers (sulphation plates) to provide a semi-quantitive estimate of the presence of sulphur-containing gases. Results are expressed as monthly sulphation rates, in mg SO_3/100 cm^2/d (milligrams of sulphur trioxide per 100 square centimetres of treated filter paper per day). Sulphur dioxide is also monitored with continuous analyzers.[3] There are three air quality objectives for this pollutant: 0.25 ppm (parts of sulphur dioxide per million parts of air, by volume), hourly average; 0.10 ppm, 24-hour average; and 0.02 ppm, annual average.

Total Reduced Sulphur

Total reduced sulphur (TRS) comprises a group of sulphur-containing gases found in emissions from kraft pulp mills, which are the sole significant TRS source in the region. At very low concentrations, TRS results in offensive odours. Higher levels may cause temporary respiratory irritation or may injure vegetation. In Ontario, a guideline of 27 ppb (parts of TRS, expressed as hydrogen sulphide, per billion parts of air, by volume), averaged over one hour, is used as an air quality objective near kraft pulp mills. TRS may be measured with sulphation plates, for semi-quantitative results, or with continuous analyzers.[4] In northwestern Ontario, the Ministry has recently phased out an older type of TRS monitor which is no longer manufactured. The monitor which replaced it, while superior in several respects, has a lower response to TRS compounds. This shortcoming results in readings which are too low. Changes to these instruments to improve their efficiency will soon be implemented.

Ozone

Ozone occurs naturally and beneficially in the upper atmosphere. Near the ground, it is a product of reactions between nitrogen oxides and hydrocarbons. If it is present at high concentrations, it may adversely affect health and damage vegetation. Since ozone-forming compounds are not emitted in large

amounts in northwestern Ontario, elevated ozone readings, if present, would suggest long-range transport from outside the region. Ozone is measured with continuous analyzers,[5] and the current air quality objective is 0.08 ppm, averaged over one hour.

Nitrogen Oxides

Nitric oxide (NO) and nitrogen dioxide (NO_2) are together termed nitrogen oxides (NO_x). Both NO and NO_2 may be emitted from natural and man-made sources. High-temperature fuel combustion, which occurs in vehicle engines and thermal power plants, is the main man-made emission source. At concentrations measured in ambient air, NO has no known adverse effects. NO may, however, oxidize to NO_2 which, in turn, may adversely affect health and visibility. Both compounds may also react with ozone and other oxidants, and contribute to the formation of acid rain. Nitrogen oxides are monitored with continuous analyzers.[6] The air quality objectives for NO_2 are 0.2 ppm, 1-hour average, and 0.1 ppm, daily average.

Fluoride

In northwestern Ontario, a tile plant near Thunder Bay is the only known significant industrial source of airborne fluoride. Fluoride may injure vegetation or impair the health of livestock which has consumed fluoride-contaminated forage. Fluoride in air is monitored with passive samplers (lime candles) which estimate mean monthly fluoride levels. The fluoride formed by the reaction of hydrogen fluoride with lime-impregnated filter paper is expressed as 40 µg F/100 cm^2/30 days during the growing season (May to September), and 80 µg F/100 cm^2/30 days during the rest of the year.

Miscellaneous

The occurrence and effects of some of the foregoing pollutants, as well as others, are also assessed by vegetation injury

and by contaminant levels in vegetation, soil and snow. Standard Ministry procedures[7,8,9] are followed in collecting and analysing these types of samples. Arsenic, chloride, fluoride,[10] sulphur and heavy metals are typical pollutants examined this way. Their levels in a study area are compared with normal background levels at sites unaffected by pollution. In 1984, the Ministry developed contaminant guidelines for vegetation, soil and snow. These guidelines are used in this report. Their exceedence suggests that contamination may be present, but does not necessarily imply adverse effects.

Dustfall, sulphation, and suspended particulate matter determinations, as well as most analyses for vegetation, soil and snow, are carried out at the Ministry's Thunder Bay laboratory. The Ministry's Toronto laboratory analyses metals, nitrate, and sulphate in suspended particulate matter, and sulphur and halides (chloride, fluoride) in vegetation and soil. The Toronto laboratory also analyses unusual contaminants (e.g.: organic compounds such as PCBs or pesticides).

The Ministry's Air Resources Branch processes the strip charts from continuous analyzers, and produces computer printouts of all air quality and meteorological data for the region. The Thunder Bay regional office has developed computer programs to improve access to air quality and meteorological data in Toronto.

RESULTS AND DISCUSSION

ATIKOKAN

Ontario Hydro Generating Station

In 1981, the Ministry and Ontario Hydro began a monitoring program around a lignite-fired generating station under construction near Atikokan. In the air quality part of this program, Ontario Hydro operates the air quality monitoring network and the Ministry collects precipitation, vegetation,

soil, and snow samples at several sites (Figure 1). By late 1985, when the 200-megawatt plant went into service, at least three years of background data had been collected.

Consultants for Ontario Hydro submit quarterly and annual air quality reports, and the Ministry prepares annual reports on terrestrial studies. Summary reports for the whole pre-operational period are in preparation. Terrestrial studies confirmed the presence of arsenic and iron contamination in vegetation and soil near the power plant. This contamination was caused by emissions from nearby iron ore pelletizing plants which operated from the mid-1970's to about 1980.[11] Mercury in Atikokan soils was also found at levels higher than expected. The source of the mercury has not been determined. The Ministry and Ontario Hydro plan to continue their monitoring programs for several years after the generating station is commissioned to ensure compliance with environmental regulations.

Particulate Matter

In 1985, at the Ministry's long-term monitoring site in the Town of Atikokan, all 57 samples of TSP complied with the 24-hour air quality objective of 120 $\mu g/m^3$. The annual geometric mean of 23 $\mu g/m^3$ was also well below the maximum acceptable limit of 60 $\mu g/m^3$.

BALMERTOWN

The Ministry has conducted air quality surveys near two gold mines in Balmertown since 1971. For many years, Campbell Red Lake Mines Limited, and the Dickenson-Sullivan Joint Venture, Arthur W. White Mine (formerly Dickenson Mines Limited), emitted significant amounts of airborne arsenic trioxide and sulphur dioxide from ore roaster stacks. In the mid-1970's, both mines reduced arsenic emissions by more than 95%. In early 1980, Dickenson changed its ore processing methods and shut down its roaster.

Arsenic

In 1985, arsenic concentrations in leaves of trembling aspen trees at 17 sites (Figure 2) near the mines remained elevated on company property but were near normal levels in the townsite. Similar findings of arsenic distribution were obtained from a snow sampling survey in January. The elevated arsenic on company property is ascribed to localized fugitive emissions from arsenic-containing wastes or concentrates. Table 1 compares arsenic readings for 14 years at selected sites on and off company property. Table 2 presents 13 years of data from planted roadside trees in the townsite. Both tables suggest that current arsenic levels in vegetation have stabilized at relatively low levels.

Except for one sample of lettuce, arsenic in garden vegetables was again well below the former limit (10 µg/g, dry weight) specified by the Health Protection Branch, Canada Department of Health and Welfare (Table 3). Because arsenic in garden soil remains high, Balmertown residents are advised to thoroughly wash vegetables from their gardens.

Mercury

Because mercury has been used in ore processing at the mines, the Ministry regularly examines mercury concentrations in local vegetation, soil and snow. The 1985 snow sampling data show that mercury was moderately elevated in snow close to the mines, but was normal in the townsite. In vegetation, mercury was within the Ministry guideline on and off company property. All vegetable samples from residential gardens met the recommended international guideline for mercury (0.5 µg/g, dry weight). Campbell Red Lake discontinued the use of mercury in late 1982, but it is still used in ore processing at Dickenson.

Sulphur Dioxide

Sulphur dioxide (SO_2) sometimes exceeds desirable levels in Balmertown. In 1985, the Ministry's Balmertown monitor recorded 114 hourly SO_2 readings and three 24-hour averages which exceeded

acceptable levels. The maximum hourly average was 0.75 ppm, three times the Ontario objective. The annual average (0.010 ppm) was satisfactory. In 1985, sulphur dioxide injury to vegetation was found in four small zones totalling about 4 hectares. A small part of one of these zones extended into the townsite (Figure 3).

During the growing season (May to September), SO_2 was above the acceptable hourly limit 61 times. During this season, Campbell Red Lake Mines operates a voluntary emission reduction program, the intent of which is to suspend ore roasting when the wind carries roaster-stack emissions over the townsite. To avoid significant vegetation damage, the Ministry has requested the company to improve the effectiveness of this abatement program.

DRYDEN

For several years, the Ministry has monitored air quality near a bleached kraft pulp mill and adjacent chlor-alkali plant in Dryden. The earliest surveys showed that mercury, particulate matter and offensive odours around the mill were often well above desirable levels. Abatement action and process changes in the 1970's successfully controlled the discharge of mercury and particulate matter. Mill modernization in the early 1980's reduced emissions of odour-causing TRS. In 1985, the Ministry continued to monitor odour levels in the town centre. It also carried out some special environmental studies around the mill's secondary treatment system (lagoon).

Lagoon

A secondary treatment system (lagoon) was constructed in late 1983 to process liquid waste from the Dryden mill. Because of public concerns about health and nuisance effects from foam, spray drift, and odours from the lagoon, the Ministry carried out special air monitoring, vegetation, and bacteria studies in 1985.

Results of these studies were recently released in two reports.[12,13] The air monitoring survey showed that concen-

trations of all identified pollutants met Ministry regulations off company property around the lagoon. No disease-causing bacteria of domestic-waste origin were present in samples of lagoon liquid. Other kinds of bacteria, commonly found in pulp mill effluents, occurred at high concentrations. Their presence, in foam particles or in spray drift from the lagoon, is judged to pose no additional health risk over their natural occurrence in the environment. The vegetation sampling and moss exposure studies indicated that fallout from foam particles and spray drift sometimes extended beyond the lagoon property line.

Because of uncertainties about the identity and toxicity of some components of the lagoon effluent, the Ministry has obtained lagoon liquid samples for further analysis. Depending on the results of these tests, further air sampling may be carried out.

Since fallout of foam and spray drift is a nuisance to area residents, the company will continue to control off-property discharge of these substances. The Ministry will closely monitor this abatement program.

Kraft Mill

Odour Levels

Offensive odours caused by reduced sulphur compounds are monitored with a continuous total reduced sulphur (TRS) analyzer near the intersection of Van Horne Avenue and Princess Street. As Table 4 shows, air quality at this town-centre location continued the trend of improvement shown in recent years. The annual average TRS concentration (1.0 ppb), and the number of hours of TRS above the provincial guideline were the lowest yet recorded. Some of this "improvement", however, may reflect a less sensitive response to TRS by a new instrument installed in May, 1984.

FORT FRANCES

During its first few years of operation, emissions from a bleached kraft pulp mill in Fort Frances resulted in excessive

fallout of particulate matter, high concentrations of malodorous gases, vegetation damage, and complaints from nearby residents. In the late 1970's, some emission reductions were achieved. In 1980, a Control Order was issued for further pollution controls. A "buffer zone" was also created through purchase of residential land adjacent to the mill.

Air quality studies in Fort Frances have been conducted regularly since 1972 near the Canadian mill, and periodically since 1974 around a similar plant owned by the same company on the U. S. side of the border (Figure 4).

Vegetation Effects

No new air pollution injury to vegetation was found near the Fort Frances mill, either on or off company property. Chloride in foliage of Manitoba maple from 18 sites (Figure 4) was well within the Ministry guideline (Table 5). Sodium exceeded the guideline on company property, but was within the guideline at all but two off-property sites (Table 5). The two off-property exceedances are considered anomalies, unrelated to mill operations. Because rainfall in the 1985 growing season was about 40 percent above normal, chloride and sodium on vegetation may have been washed off to a greater extent than usual.

There was no visible off-property damage to vegetation around the secondary treatment system on Eighth Street (Figure 5).

Particulate Matter

Dustfall results for 1985 are summarized in Table 6. None of the sites met the annual objective. Unusually high dustfall, caused by temporary construction activity, was recorded in May and June at station 62032 (cemetery). Wood fibres accounted for about 25 to 75% of total dustfall when high dustfall readings occurred at sites around the mill off company property (stations 62034, 62035, 62036). Road dust, fly ash, and insect parts were also sometimes present in significant amounts at these locations.

The company is improving its chip delivery system, which may help reduce the wood fines problem. A comparison of average dustfall over the past seven years (Table 7) shows little change from 1979 to 1985. Saltcake levels, which had dropped after 1979, rose slightly in 1985. Saltcake (sodium sulphate) is a whitish powdery substance used in the kraft pulping process. Dustfall data from early 1986 indicate that saltcake fallout increased around the mill, compared with 1985. Snow sampling, which is conducted annually, confirmed the dustfall results.

In common with dustfall, total suspended particulate matter (TSP) showed no significant change in 1985 from earlier years. The annual average TSP at the monitoring site near the mill (station 62035) was 51 $\mu g/m^3$ and met the provincial objective. Five of the 55 daily readings exceeded the 24-hour objective. The annual average TSP at the Fort Frances cemetery (station 62032) was 26 $\mu g/m^3$, which is normal for this location and well within the Ontario objective. There were no exceedences of the daily objective at this site.

Odour Levels

Sulphation rate averages at the seven monitoring stations in Fort Frances have shown little change over the past five years. On the other hand, average TRS declined from 1984 to 1985 at all three sites where continuous measurements are made (Table 8). At least part of this decrease is ascribed to TRS monitors now in service which produce readings below the true value. These monitors will be modified in the summer of 1986 to restore their TRS response to a level closer to actual concentrations.

Table 8 shows that while TRS levels have declined in recent years, there is still a large number of guideline exceedences. The TRS at stations 62052 and 62051 are influenced mostly by emissions from the Fort Frances kraft mill. Readings at station 62032 are affected mainly by discharges from the kraft mill in International Falls, Minnesota, and to a lesser degree by TRS from the Fort Frances kraft mill and from the Canadian mill's

secondary treatment system (lagoon). Sulphation plate readings at the north end of Fort Frances were well above normal background, which indicated that the lagoon was a significant source of offensive odours. A special air quality study near the lagoon, carried out by the Ministry in 1985, showed that off-property TRS exceeded the guideline. Under a Program Approval from the Ministry, the company is conducting studies on improvements to its secondary treatment system. When these studies are complete, a new Control Order will be developed by the end of 1986. Odour controls at the mill and lagoon, as well as saltcake and wood fines emissions, will be addressed in the new Order.

KENORA

For many years, the Ministry has monitored air quality near a sulphite pulp mill in Kenora. Occasional upset conditions at the mill have caused localized vegetation damage, and fallout of particulate matter emitted from the mill's power boiler stack has sometimes been a nuisance to nearby residents.

Vegetation Effects

No complaints of air pollution damage to vegetation were received in 1985. A brief survey in July confirmed that there was no sulphur dioxide injury to vegetation around the mill.

Particulate Matter

As Table 9 shows, average dustfall in Kenora in 1985 was slightly higher than that for the preceding three years. Dustfall frequently exceeded the monthly objective at station 61007. Levels at the other sites in the four-station network (Figure 7) were usually acceptable. Flyash, wood or bark char, and road dust were major components of dustfall when elevated readings occurred. A Control Order requires, by June 30, 1988, compliance with Ministry regulations for particulate matter.

Sulphation Rates and Sulphur Dioxide

Average sulphation rates in 1985 were about the same as in 1984 (Table 10). Sulphur dioxide concentrations at station 61030 met all provincial air quality objectives from August, 1983, when monitoring began, to August, 1985, when monitoring terminated.

LONGLAC

Particulate Matter

To obtain data on particulate matter around two conical wood-waste burners in Longlac, a network of five dustfall jars and one high-volume sampler was established in late 1983 (Figure 7).

Of the 55 daily air samples obtained at station 63070 in 1985, five exceeded the air quality objective of 120 $\mu g/m^3$. The maximum 24-hour reading was 219 $\mu g/m^3$. The annual mean, 32 $\mu g/m^3$, was well below the acceptable limit of 60 $\mu g/m^3$. The dustfall data are summarized in Table 11. Several monthly readings were above the desirable level, particularly at station 63071. The highest reading at this site, in June, was caused mainly by wood fines. Dustfall at three of the five sites met the annual objective. Averages at all locations were below those reported for 1984. The 1984 and 1985 data do not indicate a serious fallout problem in the townsite from the wood waste burners. Hi-vol monitoring was terminated in December, 1985, but dustfall measurements will continue at least to the end of 1986.

MARATHON

Historically, airborne contaminants of concern at Marathon have included mercury, particulate matter, and sulphur compounds from a bleached kraft pulp mill and adjacent chlor-alkali plant. Mercury emissions ceased when the chlor-alkali plant was closed in 1977. Fallout of particulate matter in the townsite was shown in several surveys to be negligible. The Ministry currently maintains five air quality monitoring stations in Marathon (Figure 8) and one in Heron Bay.

Odour Levels

Table 12 shows that average sulphation levels in the townsite have been variable, with no clear trend, since major mill modernization and pollution control programs were completed in 1978.

Table 13 indicates that the average TRS level and maximum TRS reading increased in 1985, compared with the two preceding years. The number of guideline exceedences also approximately doubled. To alert the mill when community odour levels exceed the desirable limit, the company installed telemetry equipment at the end of 1984 to transmit TRS readings directly from the Ministry's monitor to the mill. A decrease in TRS emissions is expected as a result of a mill modernization program currently in progress.

Sulphur Dioxide

For the nine months of available data in 1985, SO_2 met all air quality objectives at station 63034. Because SO_2 concentrations have been well below SO_2 air quality objectives since monitoring began in August 1984, further measurement was discontinued in early October, 1985.

Particulate Matter

Following the recent creation of wood chip piles near the pulp mill, the Ministry received complaints of wood fines fallout from adjacent residents. The company is monitoring dustfall in the area, and the Ministry recently conducted a snow sampling survey. It appears that the fallout problem is restricted to a small area close to the chip piles. The company is investigating ways to reduce dust emissions from the chip piles so that fallout of wood fibres does not cause a nuisance to area residents.

RED ROCK

The Ministry operates a small air quality monitoring network in the Town of Red Rock to measure dustfall and odour levels near a kraft pulp mill. The network comprises four dustfall jars and sulphation plates at stations 63080 to 63083, and a continuous TRS analyser at station 63084 (Figure 9).

Particulate Matter

Table 14 summarizes dustfall in Red Rock for the period before (1980-82) and after (1983-1985) a new recovery furnace was installed at the local pulp mill. Both total dustfall and saltcake in dustfall declined sharply after the new recovery furnace started up in late 1982. This reduction in particulate fallout is also confirmed by data in a recent report[14] on a moss exposure study. The study showed a significant decline in sodium in moss after the new recovery furnace was installed. In 1985, total dustfall at two of the four monitoring sites met the annual air quality objective. Most of the significant exceedences of the monthly objective occurred at the monitoring site (station 63080) on mill property. A Control Order to be served on the company in 1986 requires it to identify emissions sources of particulate matter by September, 1987. This emission inventory report will also assess the need and feasibility of further controls on discharges of particulate matter.

Odour Levels

Operating problems at the mill resulted in an increase in the number of exceedences of the TRS guideline from 23 in 1984 to 117 in 1985 (Table 15). Some of these problems have already been resolved and others are under investigation. The company will soon be submitting to the Ministry a plan to meet the TRS guideline. Under the new Control Order, consistent compliance with the guideline is required by the end of 1988. Emission monitoring for TRS or equivalent will also be carried out.

TERRACE BAY

Previous surveys have shown that the kraft pulp mill in Terrace Bay does not cause fallout of particulate matter in the adjoining townsite. Therefore, the Ministry's monitoring program is directed toward measurement of odour levels in the townsite and at three points where an effluent ditch from the mill crosses the TransCanada Highway (Figure 10).

Odour Levels

Average sulphation rates in 1985 increased relative to 1984 and were similar to results for 1982 and 1983 (Table 16). TRS data (Table 17) showed that, during 1985, there were 60 hourly readings above the provincial guideline of 27 ppb at the Ministry's monitoring site (station 63090, Figure 10). The maximum hourly average was 200 ppb. The number of guideline exceedences, the maximum reading, and the average annual TRS concentration were all significantly higher in 1985 than in previous years. TRS data from the Ministry's monitor are continously telemetered to the mill. The Ministry is currently negotiating with the company to secure further abatement of TRS emissions from the mill's non-condensible gas system.

THUNDER BAY

The Ministry maintains a 10-station air quality monitoring network in Thunder Bay. The locations of these sites, plus those operated by Ontario Hydro, are shown in Figure 11. Three of the Ministry's Thunder Bay monitoring stations (63005, 63022, 63040) are part of the NAPS (National Air Pollution Surveillance) network operated by Environment Canada. In addition to its network of seven sulphur dioxide monitors, Ontario Hydro has dustfall jars at nine sites on and near its Mission Island property to measure dust from flyash disposal and coal storage areas around its power plant. In October, 1985, Hydro's dustfall network was reduced from nine sites to five. The number of Hydro SO_2 monitors decreased in December from seven to five, with the

termination of monitoring at stations 63050 (Paipoonge) and 63051 (John Street). The following discussion reviews data from the Thunder Bay monitoring network, and includes brief summaries of some special studies carried out in the Thunder Bay area in 1985.

Particulate Matter

Dustfall

Dust emitted from grain elevators was formerly a nuisance to Thunder Bay residents. Dustfall measurements near the elevators began in 1970, and the monitoring network has been revised periodically since then. The 1985 data for the 10 sites now monitored are summarized in Table 18. During the year, average dustfall exceeded the maximum acceptable limit at two of the 10 sites. Most of the elevated readings occurred at station 63047 (Totem Trailer Court). Road dust, fly ash, and wood char particles accounted for much of the dustfall at this site. Emissions from coal-fired power boilers at Great Lakes Forest Products Limited have caused a local nuisance problem in the past. As shown in Table 19, this fallout has decreased sharply since 1983, when improved dust collection equipment was installed in the mill's power boilers.

Suspended Particulate Matter and Soiling Index

Total suspended particulate matter (TSP) was generally very satisfactory throughout Thunder Bay in 1985 (Table 20). Over ninety-nine percent of the total samples for all six monitoring sites were below the 24-hour maximum acceptable limit of 120 $\mu g/m^3$. The annual objective was met at all locations. Filters from the two city-centre stations (63005 and 63022) had acceptable concentrations of heavy metals, including lead. Levels of sulphate and nitrate, influenced by long-range transport, varied considerably.

At station 63040, soiling index slightly exceeded the daily air quality objective for four days in January and one day in February. The annual objective for this pollutant was easily met.

Gaseous Pollutants

Sulphur Dioxide (SO_2)

The principal industrial sources of sulphur dioxide in Thunder Bay are a 310-megawatt lignite-fired generating station and four pulp and paper mills. Collectively, these sources are relatively small, and total SO_2 emissions from the city are less than 100 metric tons per day. The network of nine SO_2 monitors (seven belonging to Ontario Hydro and two owned by the Ministry) showed, with two exceptions, full compliance for all SO_2 air quality objectives in 1985 (Table 21). The hourly objective for SO_2 was slightly exceeded on Mt. McKay for one hour on February 5 and one hour on December 9. The probable emission source for these two elevated readings was Great Lakes Forest Products Limited.

Total Reduced Sulphur (TRS)

At the Montreal Street monitoring site (station 63046), the TRS guideline (27 ppb) was not exceeded during the year (Table 22). The annual average was similar to that recorded for the preceding three years. TRS concentrations somewhat higher than current levels might be reported when our TRS monitors are modified in 1986 to improve their response to TRS compounds.

Ozone (O_3)

Ozone did not exceed the maximum acceptable limit (80 ppb) during 1985 at the Ministry's monitoring site (station 63040). The highest one-hour average, 47 ppb, was lower than the maximum usually recorded. Highest readings were usually associated with southerly winds. Several studies have shown that ozone is a long-range transport pollutant whose primary sources are large urban and industrial centres.

Special Studies

Pulp Mills

Surveys again showed that vegetation near the two sulphite pulp mills in Thunder Bay was free of visible symptoms of air pollution damage.

Thunder Bay Terminals Limited

A report on 1984 air quality monitoring near Thunder Bay Terminals Limited[15] showed that this coal terminal continued to operate satisfactorily. There has been no increase in dust levels at off-property monitoring sites since coal shipments began in 1978.

Acid Rain Studies, Hawkeye Lake

Most of the field work for studies on the terrestrial effects of acid rain in northwestern Ontario have been completed. Much of the work in this 4-year program was carried out in a 95-hectare watershed near Hawkeye Lake, about 40 kilometres north-northwest of Thunder Bay. Environmental monitoring at this site included continuous measurement of sulphur dioxide, nitrogen oxides and ozone. In 1985, sulphur dioxide and nitrogen oxide levels met all air quality objectives and were only occasionally above the detection limit (about 5 ppb). The maximum ozone reading was 73 ppb, which was below the acceptable limit of 80 ppb. The results of other investigations at Hawkeye Lake will be reported separately.

Great Lakes Ceramics Inc.

In 1985, Great Lakes Ceramics Inc. began producing tile at a plant in Rosslyn Village, about 15 km west of Thunder Bay. This plant, which last operated in 1982, has manufactured bricks and tile for many years under several different owners. In the latter part of 1985, tile production under the new management was largely experimental. From September to December, fluoride

levels were monitored with lime candles at six sites near the plant. Two of the 24 values during this period exceeded the maximum acceptable level. Tile production plans at Great Lakes Ceramics are currently uncertain. If the company resumes manufacturing, the Ministry will conduct appropriate air quality monitoring and vegetation surveys.

MacMillan Bloedel Industries Limited

The Ministry has conducted periodic dustfall and snow sampling surveys around the MacMillan Bloedel waferboard plant, 15 km west of Thunder Bay. Surveys in 1984 and 1985 indicated that fallout of particulate matter on residential property near the plant met Ministry regulations.[16] The most recent dustfall results, for the period December, 1985 to March, 1986, were similar to those for the 1984-85 survey.

ACKNOWLEDGEMENT

The assistance of staff of the Atmospheric Environment Service, Atikokan Weather Station, for operating a high-volume sampler is gratefully acknowledged.

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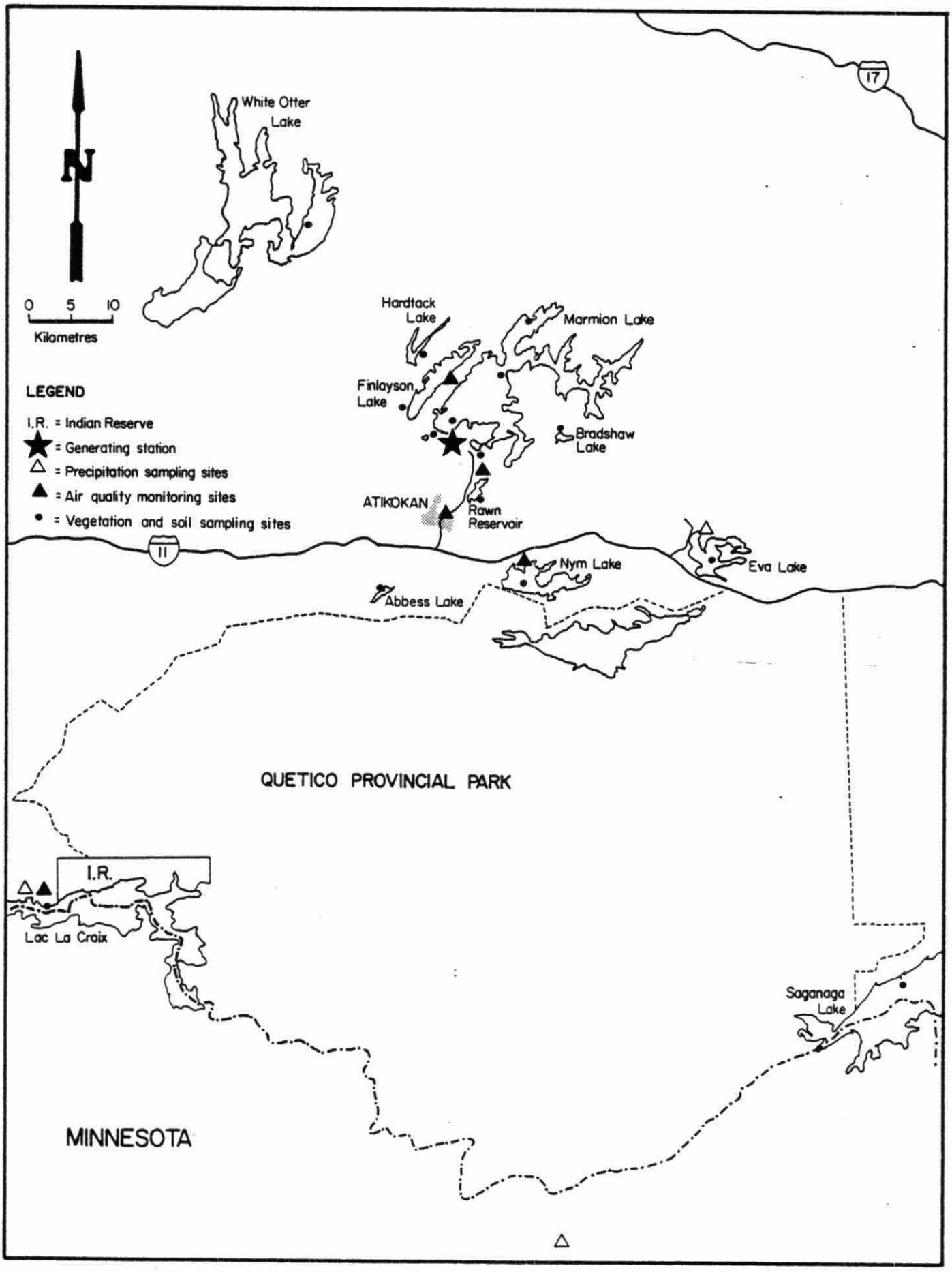


Figure 1. Air quality assessment sites, Ontario Hydro generating station, Atikokan.

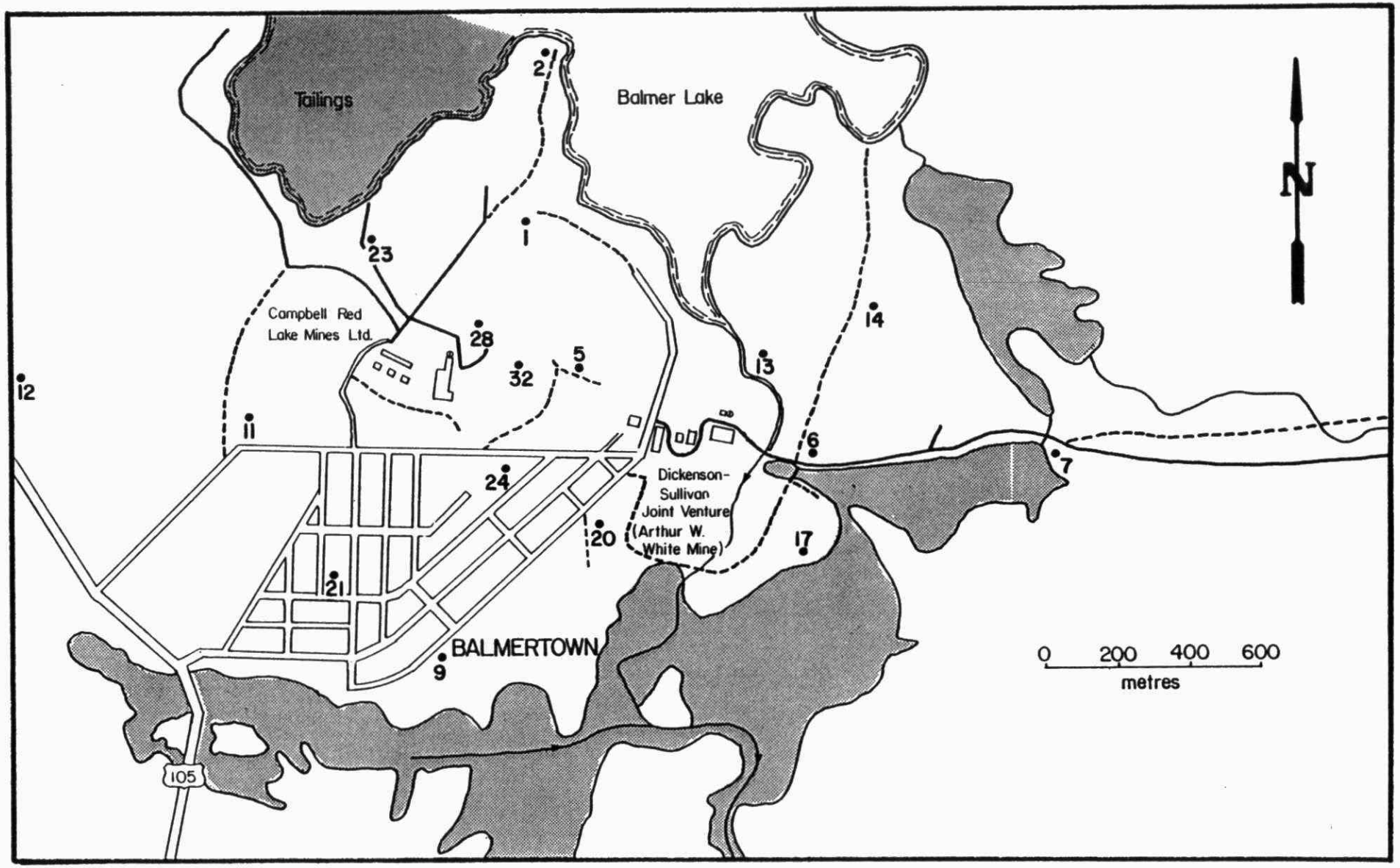


Figure 2. Trembling aspen sampling sites, Balmertown, 1985.

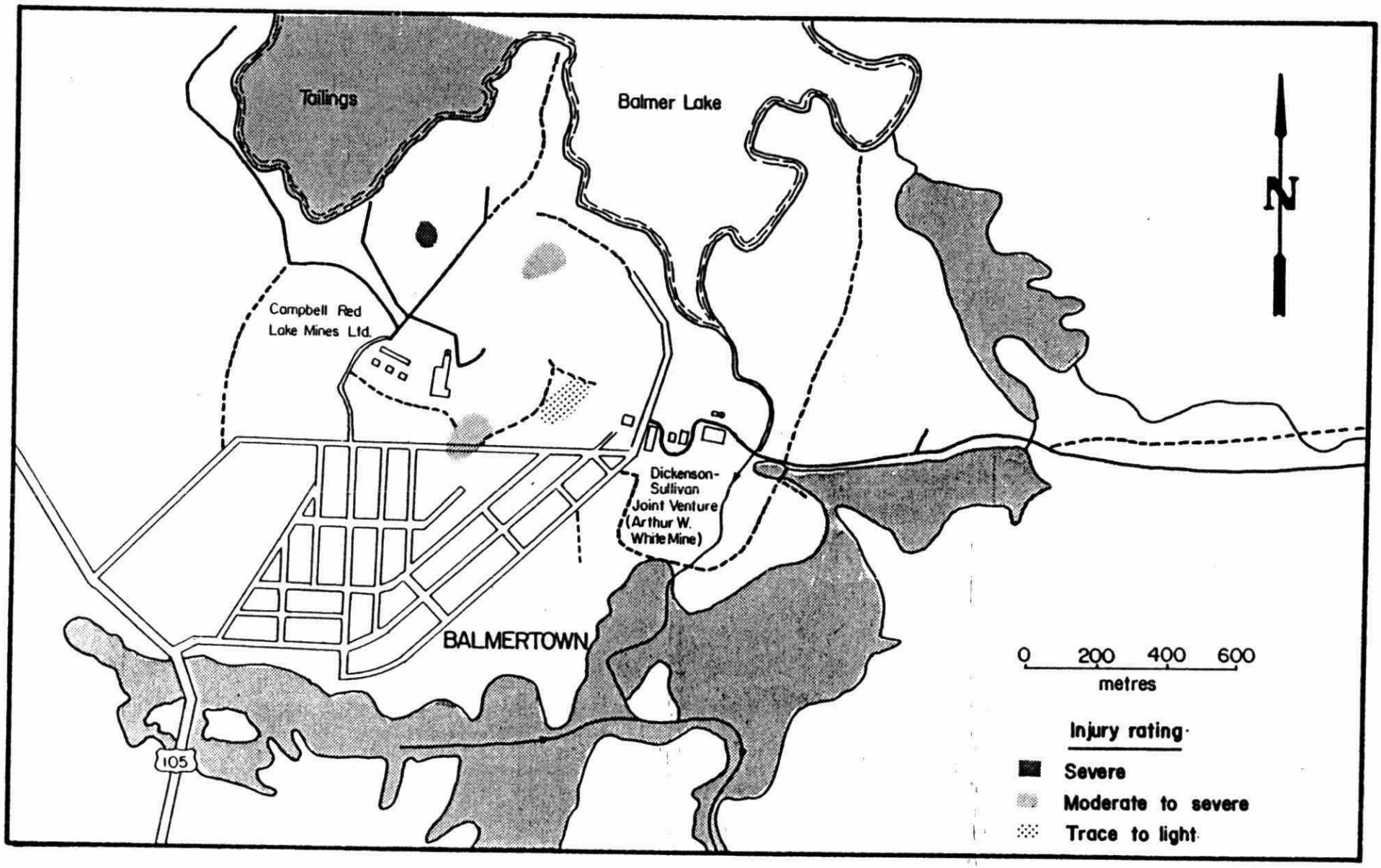


Figure 3. Sulphur dioxide injury to vegetation, Balmertown, August, 1985.

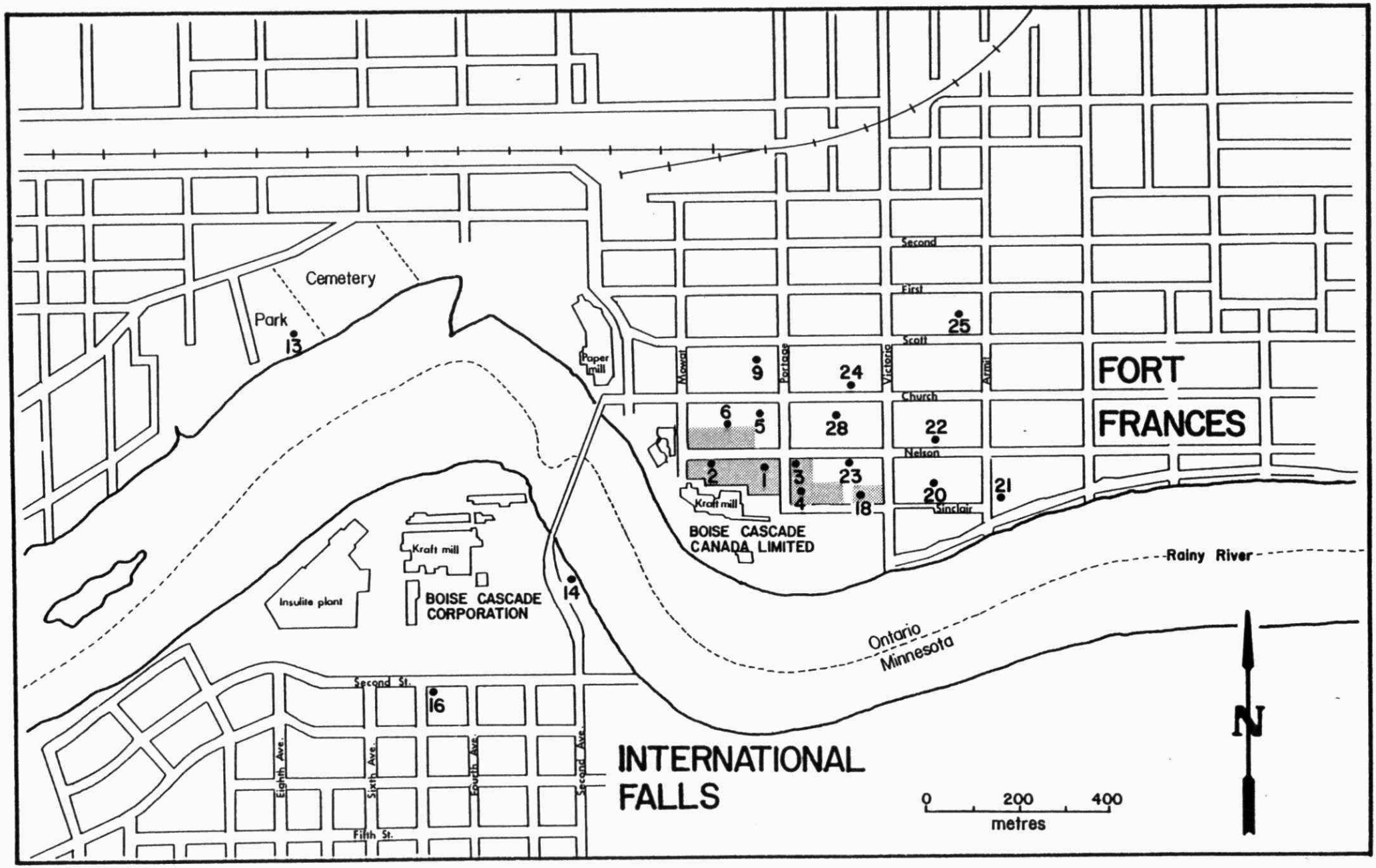


Figure 4. Manitoba maple sampling sites, Fort Frances, August, 1985. Buffer zone

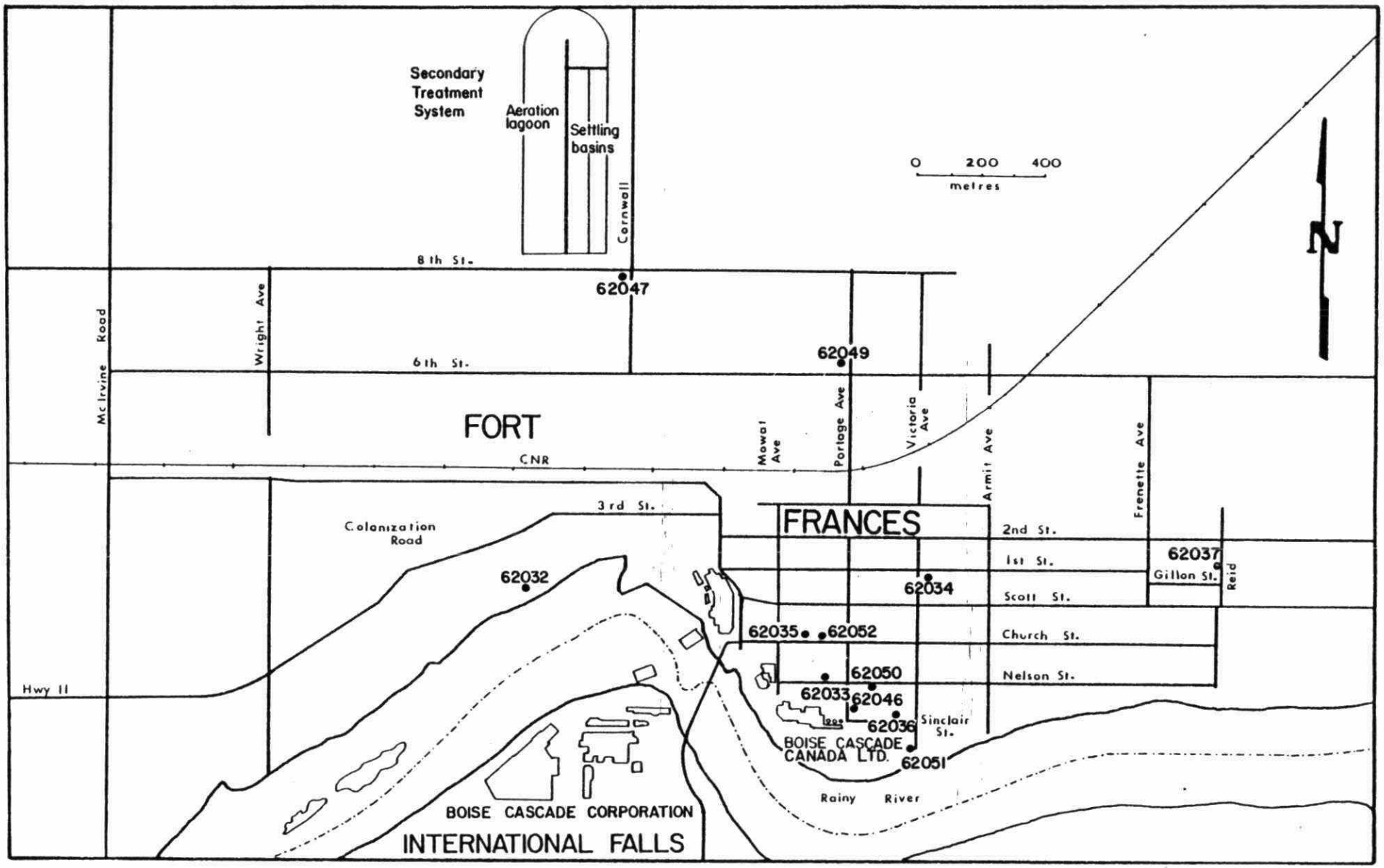


Figure 5. Air quality monitoring sites, Fort Frances, 1985.

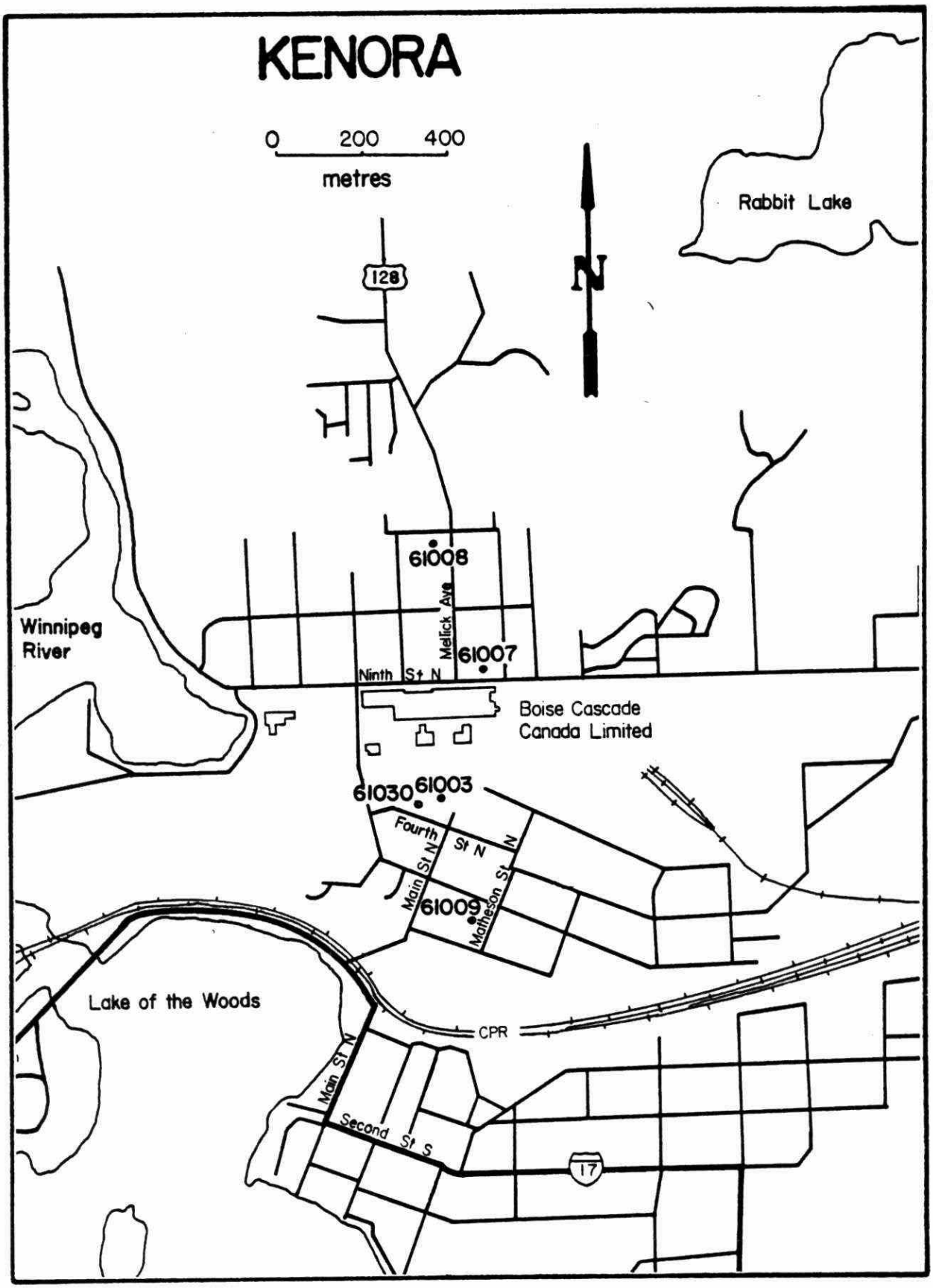


Figure 6. Air quality monitoring sites, Kenora, 1985. (SO_2 only at 61030).

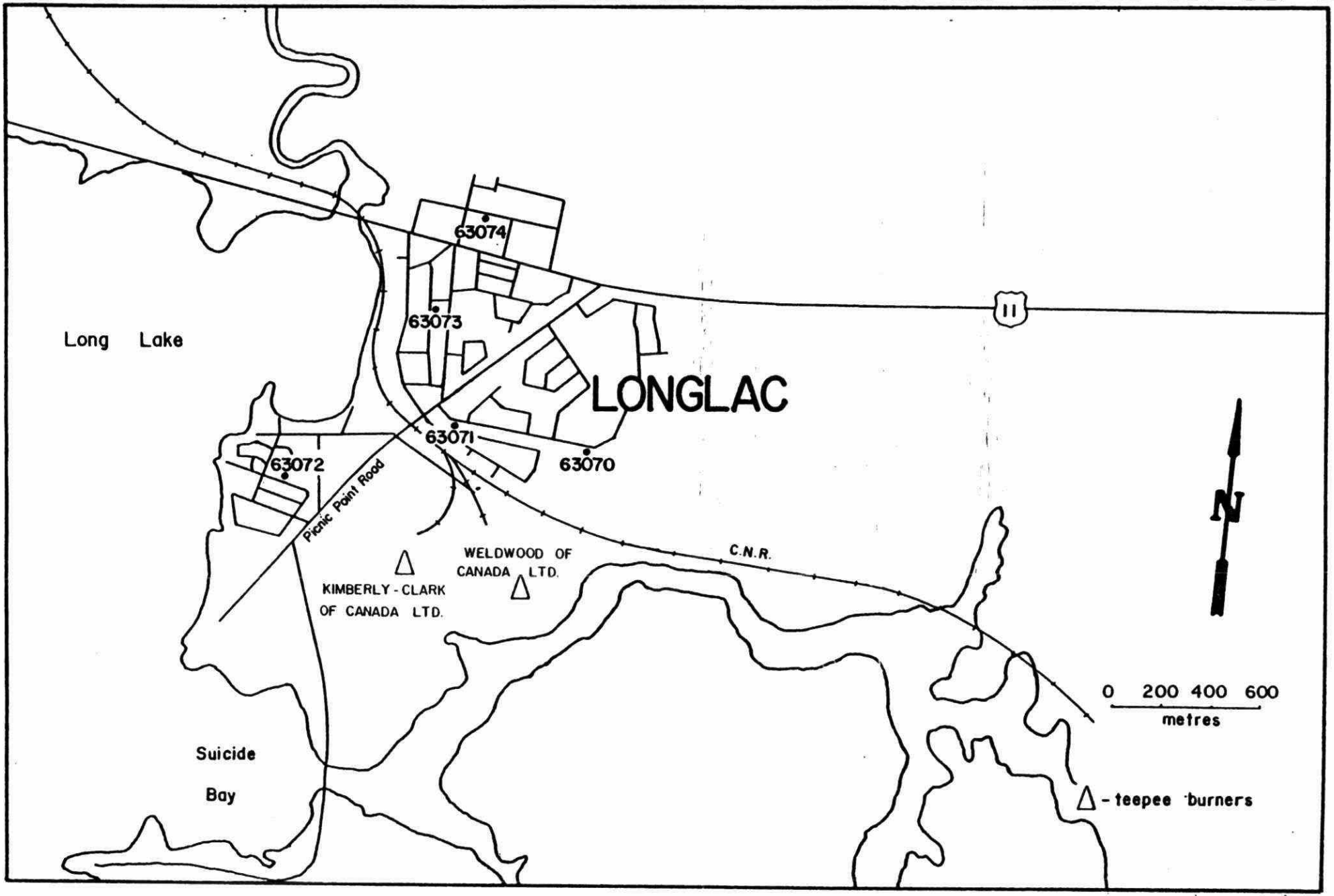


Figure 7. Air quality monitoring sites, Longlac, 1985. (hi-vol at station 63070 only).

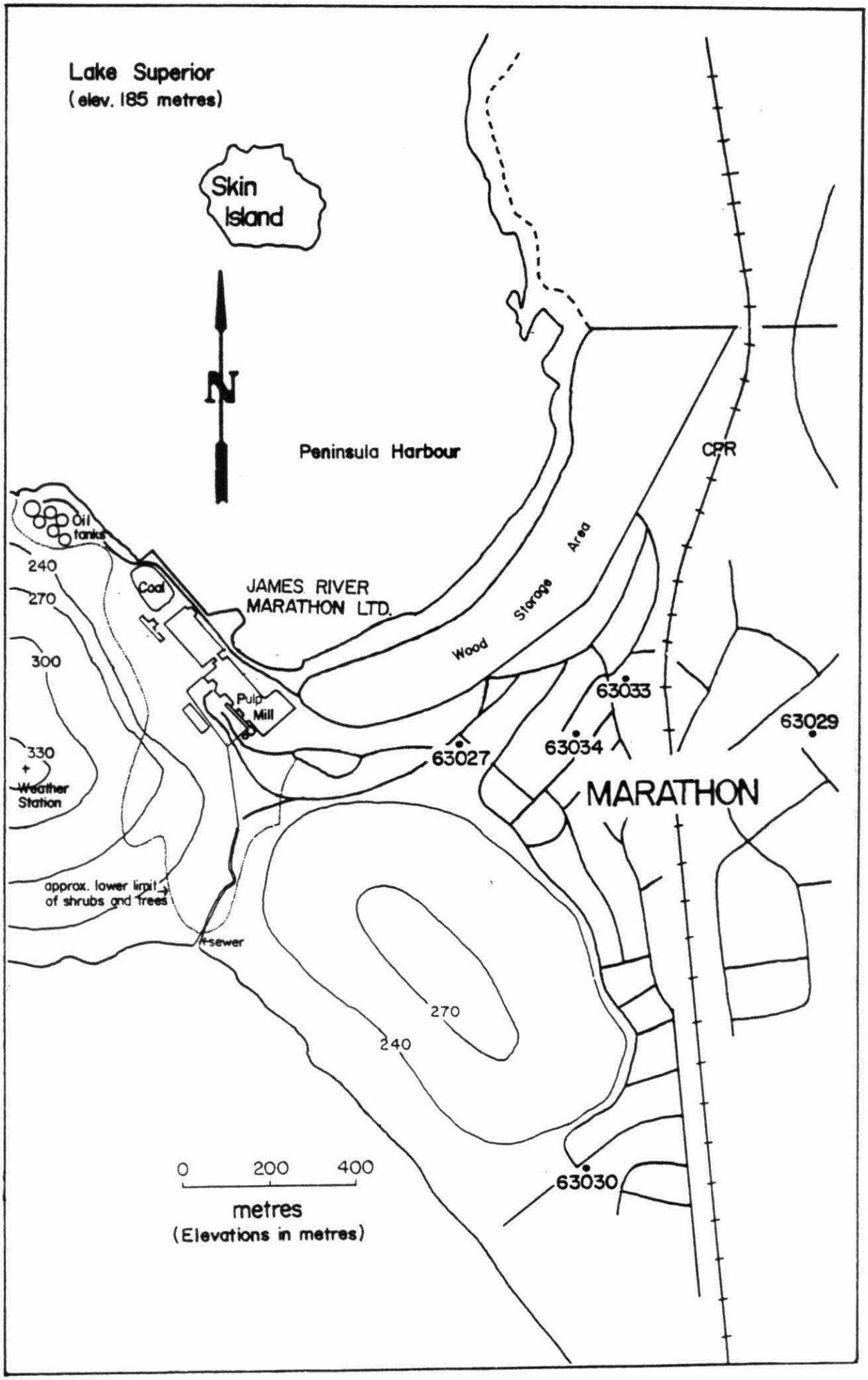


Figure 8 . Air quality monitoring sites, Marathon, 1985. (except station 63032, Heron Bay).

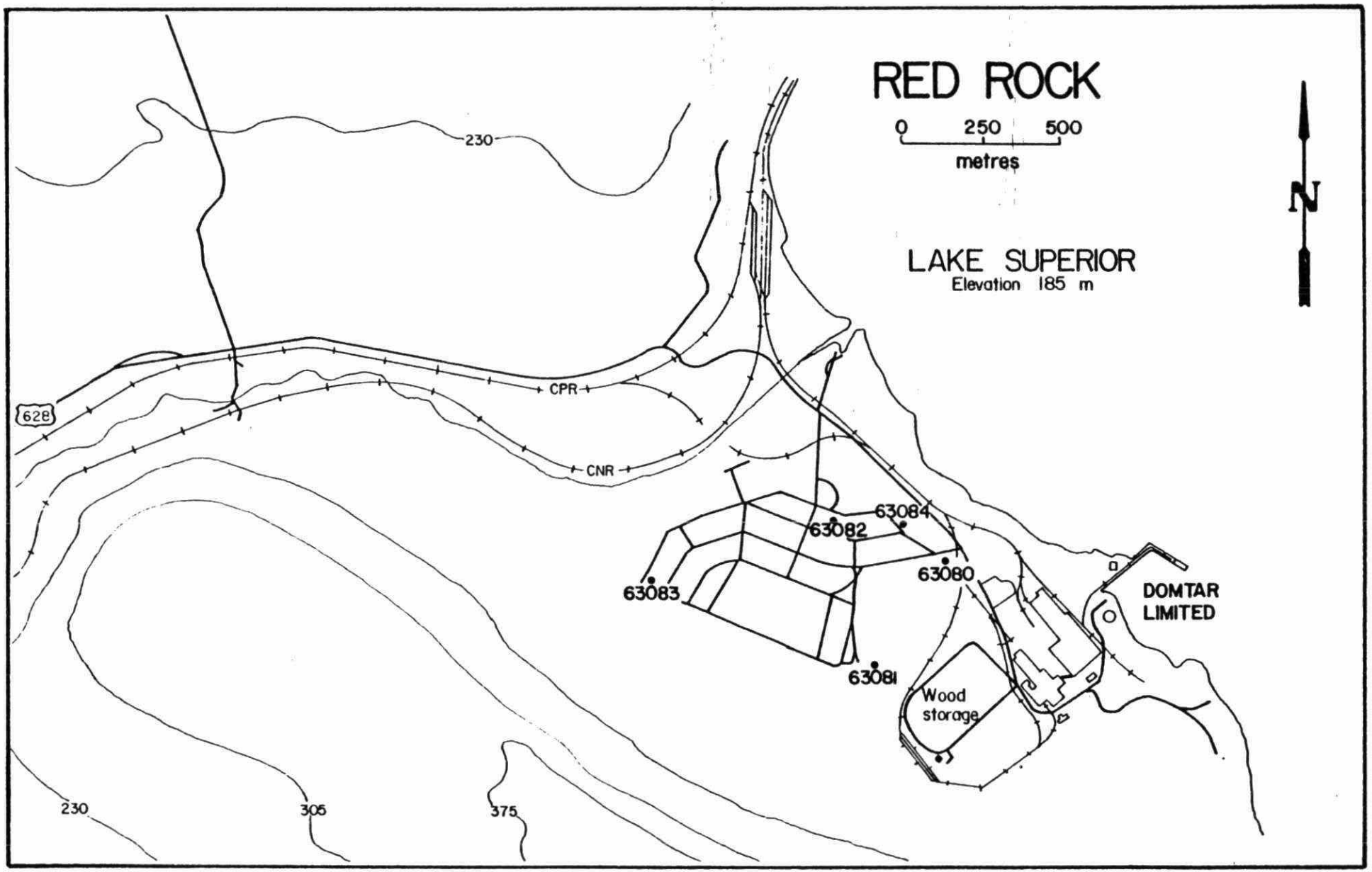
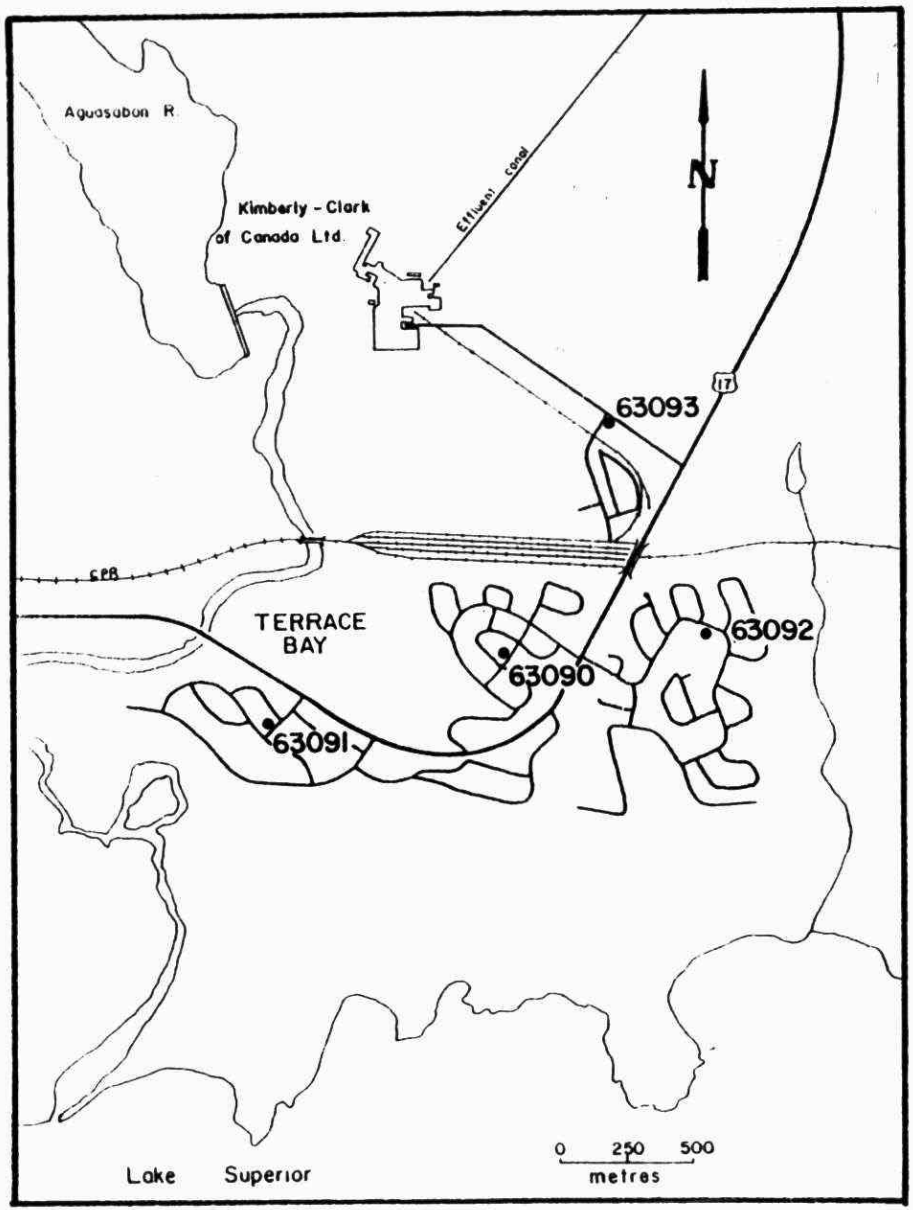


Figure 9. Air quality monitoring sites, Red Rock, 1985.



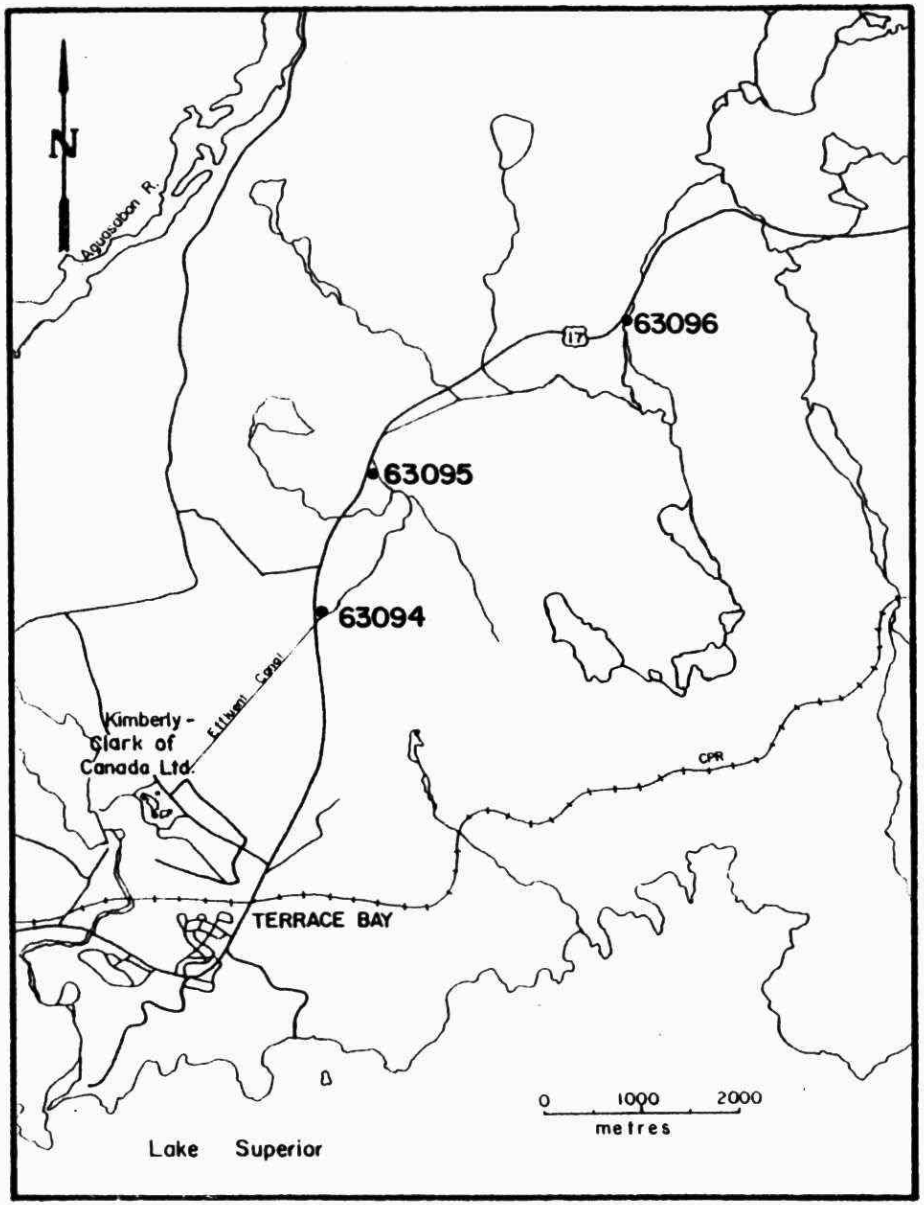


Figure 10. Air quality monitoring sites, Terrace Bay, 1985. (TRS at station 63090 only).

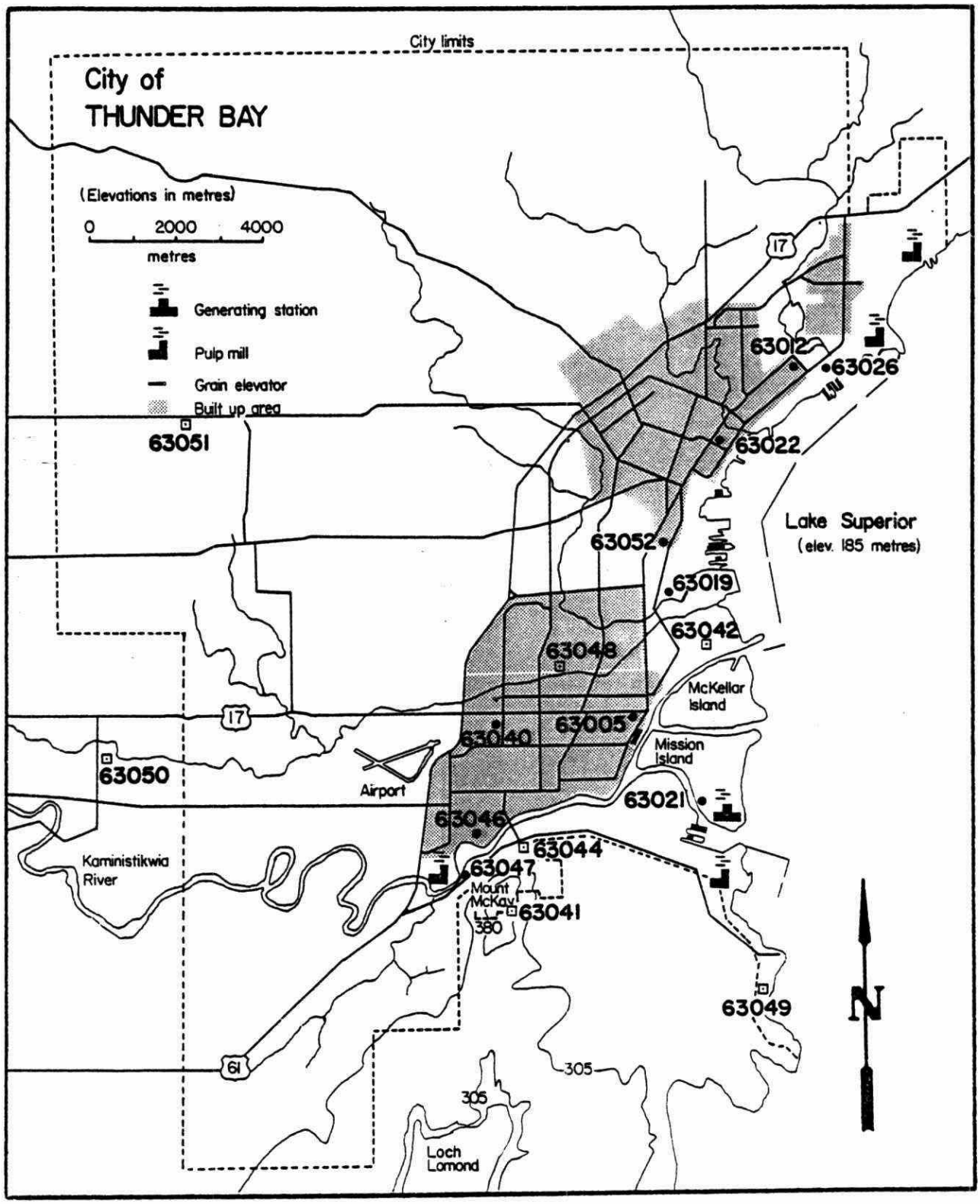


Figure 11. Air quality monitoring sites, Thunder Bay, 1985.
(⊡ Ontario Hydro sites)

TABLE 1. Arsenic content (µg/g, dry weight) of unwashed trembling aspen foliage near Balmertown, 1972 to 1985.

Site[a]	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1			26[b]	31	10	5	4	3	6	5	9	5	4	4
2			22	26	6	12	9	3	6	4	12	6	6	6
5	160	550	29	33	18	12	9	22	28	6	60	19	11	16
6	78	400	200	260	50	8	33	11	55	63	36	38	14	13
7	21	81	43	29	5	4	20	4	4	2	5	5	3	4
9[c]	260	410	19	6	6	5	5	9	3	5	5	4	7	6
11	98	110	10	7	2	4	2	5	3	4	6	4	3	13
12	27	41	9	9	4	3	3	6	1	2	13	2	4	2
20[c]				6	5	7	6	13	5	3	25	3	14	5
21[c]				53	8	4	3	18	9	7	3	3	3	6
24[c]				26	13	17	5	11	17	9	25	5	6	11
Controls	<1	8	3	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

[a]Shown in Figure 2.

[b]Values above contaminant guideline (2 µg/g) are underlined.

[c]Sites in townsite area.

TABLE 2. Average arsenic content (µg/g, dry weight)[a] of unwashed foliage from planted roadside Manitoba maple (Acer negundo) and white elm (Ulmus americana) trees, Balmertown, 1973 to 1985.

Year	Side of tree[b]	Dickenson & Mine Road	Balmertown public school	Fifth St. & Mine Road	Controls
1973	Facing	504[c]	734	352	19
	Away	323	432	202	25
1974	Facing	70	36	20	4
	Away	31	21	12	
1975	Facing	138	76	34	4
	Away	58	46	18	
1976	Facing	18	12	20	2
	Away	18	9	11	
1977	Facing	13	6	8	<1
	Away	16	5	8	
1978	Facing	5	5	5	<1
	Away	4	4	3	
1979	Facing	69		8	2
	Away	22		7	
1980	Facing	7	5	6	1
	Away	5	5	3	
1981	Facing	11	7	8	<1
	Away	12	7	5	
1982	Facing	14	8	10	<1
1983	Facing	18	7	-	<1
1984	Facing	8	4	3	<1
1985	Facing	12	6	5	<1

[a]Values for 1975 to 1979 are averages of triplicate samples. Those for other years represent single samples.

[b]Facing and away from gold mines.

[c]Values above contaminant guideline (2 µg/g) are underlined.

TABLE 3. Average arsenic levels[a] (µg/g, dry weight) in washed vegetables and surface soil (0-5 cm) from three Balmertown gardens, 1973-1985[b].

Sample	1973	1975	1977	1979	1981	1983	1985
				Balmertown			
Potato leaves[c]		24	9	37	8	8	14
Potato tubers		2	<1	<1	<1	1	<1
Beet leaves	180[d]	8	7	13	2	5	2
Beet roots	40	9	6	8	<1	5	1
Lettuce leaves	140	18	7	12	6	8	9
Garden soil		150	360	93	75	100	90
Lawn soil		450	340	270	320	330	180
				Red Lake (control)			
Potato leaves[c]		2	2	5	<1	2	1
Potato tubers		<1	<1	<1	<1	<1	<1
Beet leaves	3	<1	<1	<1	<1	<1	<1
Beet roots	2	<1	<1	<1	<1	<1	<1
Lettuce leaves		<1	<1	1	2	<1	1
Garden soil		10	7	6	3	8	7
Lawn soil		10	8	24	7	15	9

[a]Values for 1975 to 1979 are averages of triplicate samples. Those for other years represent single samples.
[b]Two gardens in 1979, 1984 and 1985. [c]Unwashed.
[d]Values above contaminant guidelines (2 µg/g for vegetation, 10 µg/g for soil) are underlined.

TABLE 4. Summary of concentrations (ppb) of total reduced sulphur, Dryden, 1977-1985.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above guideline
1977	325	3.7	164	270
1978	282	6.7	479	400
1979	200	8.7	236	391
1980	275	6.1	436	476
1981	279	5.5	190	405
1982	312	2.1	139	153
1983	257	1.5	121	68
1984	327	1.1	187	28
1985	340	1.0	51	17

TABLE 5. Average chloride and sodium concentrations in unwashed Manitoba maple foliage, Fort Frances-International Falls, 1980-1985.

Site[a]	Chloride (%, dry weight)			Sodium (µg/g, dry weight)		
	1980	1983	1985	1980	1983	1985
1[c]	1.20[b]	0.40	0.21	1800[b]	1000	680
2[c]	0.81	0.36	0.18	1400	1900	690
3[c]	0.87	0.26	0.15	1200	210	560
4[c]	0.71	0.24	0.13	620	340	570
5	0.35	0.23	0.14	260	670	180
6	0.36	0.34	0.18	390	1800	580
9	0.22	0.16	0.12	150	430	130
13	0.04	0.04	0.04	83	210	140
14	0.08	0.08	0.12	53	470	47
16	0.53	0.12	0.14	73	160	110
18	0.21	0.12	0.08	120	65	310
20	0.10	0.09	0.08	250	160	420
21	0.15	0.14	0.16	250	<25	120
22	0.13	0.13	0.14	240	63	490
23	0.26	0.10	0.09	280	98	200
24	0.42	0.22	0.25	210	83	79
25	0.17	0.10	0.26	410	96	130
28		0.14	0.13		110	91
Controls	0.10	0.06	0.06	100	<25	27

[a]See Figure 4 for station locations.

[b]Values above contaminant guidelines (350 µg/g for sodium and 0.85 for chloride) in vegetation are underlined.

[c]Sites on company property.

TABLE 6. Average annual dustfall (g/m²/30 d), Fort Frances, 1985.

Monitoring station	Total dustfall	Insoluble dustfall	Saltcake in dustfall
62032	4.9	2.9	0.4
62033	11.3	4.8	2.6
62034	9.2	6.5	0.7
62035	9.2	5.3	1.0
62036	13.5	7.6	1.5
62037	4.9	2.1	0.5
62046	12.7	6.9	1.4
Averages	9.4	5.1	1.2
% of total dustfall		54	13

[a]Values above the maximum acceptable limit (4.6 g/m²/30 d) are underlined.

TABLE 7. Average annual dustfall (g/m²/30 d) at six Fort Frances monitoring sites[a], 1979-1985. Percentages of total dustfall are shown in parentheses.

Parameter	1979	1981	1983	1985
Total dustfall	8.7	7.6	7.5	9.4
Insoluble dustfall	4.0 (46)	4.4 (58)	4.1 (55)	5.1 (54)
Saltcake in dustfall	1.7 (20)	1.0 (13)	1.0 (13)	1.2 (13)

[a]Stations 62032, 62033, 62034, 62036, 62037 and 62046.

TABLE 8. Summary of total reduced sulphur concentrations (ppb) at stations 62030, 62052, 62032 and 62051, Fort Frances, 1976-1985.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above guideline
	Station 62030/62052			
1976	309	12.8	458	916
1977	294	15.4	480	969
1978	304	16.1	540	1035
1979	344	10.2	353	911
1980	352	9.3	499	872
1981	277	12.0	279	806
1982	320	8.8	543	685
1983[a]	336	4.9	254	418
1984[a]	332	2.8	98	135
1985[a]	363	2.0	191	87
	Station 62032			
1976	139	2.5	116	91
1977	225	3.3	129	176
1978	281	2.5	134	141
1979	306	2.9	140	178
1980	307	3.3	124	210
1981	271	3.1	211	202
1982	269	2.1	99	115
1983	309	2.8	87	180
1984	314	1.9	74	38
1985	363	1.1	61	28
	Station 62051			
1983	349	4.3	161	345
1984	366	5.3	284	509
1985	315	3.6	166	218

[a]Station 62052.

TABLE 9. Average annual dustfall (g/m²/30 d), Kenora, 1981-1985.

Station[a]	Location	1981	1982	1983	1984	1985
61003	Fourth/Main	4.7[b]	3.1	2.5	4.8	5.4
61007	Melick/Ninth	14.1	10.0	7.0	10.9	9.7
61008	Melick/Eleventh	4.1	2.7	2.5	3.3	5.6
61009	Third/Matheson	7.1	4.5	3.3	4.5	5.1
	Averages	7.5	5.1	3.8	5.9	6.4

[a]See Figure 6.
[b]Values exceeding maximum acceptable level of 4.6 are underlined.

TABLE 10. Average annual sulphation rates (mg SO_3/100 cm²/d), Kenora, 1981-1985.

Station[a]	Location	1981	1982	1983	1984	1985
61003	Fourth/Main	0.11	0.07	0.06	0.05	0.07
61007	Melick/Ninth	0.21	0.10	0.10	0.07	0.06
61008	Melick/Eleventh	0.18	0.15	0.20	0.11	0.09
61009	Third/Matheson	0.07	0.05	<0.05	<0.05	<0.05
	Averages	0.14	0.09	0.10	0.06	0.06

[a]See Figure 6.

TABLE 11. Average annual dustfall levels (g/m²/30 d), Longlac, 1985.

Station[a]	Location	Monthly range 1985	Annual average 1984	Annual average 1985
63070	Sewage Plant	1.7 - 10.5[b]	5.8[b]	5.0
63071	Centennial Drive	1.7 - 14.6	7.7	6.9
63072	Poplar Street	0.9 - 6.4	6.3	4.2
63073	Dieppe Road	0.7 - 7.6	4.2	3.0
63074	Riverview Street	0.2 - 10.1	4.3	3.9

[a]See Figure 7.
[b]Averages exceeding the objectives of 7.0 (monthly) or 4.6 (annual) are underlined.

TABLE 12. Average annual sulphation rates (mg SO_3/100 cm^2/d), Marathon, 1979 to 1985.

Station	Location	1979	1981	1983	1985
63027	McLeod/Abrams	0.15	0.10	0.19	0.13
63029	Marathon Shell	0.17	0.09	0.13	0.10
63030	Howe/Yawkey	0.15	0.11	0.12	0.08
63032	Heron Bay	0.10	0.07	0.06	0.06
63033	Water Tower	0.16	0.15	0.21	0.15
	Averages	0.15	0.10	0.14	0.10

TABLE 13. Summary of TRS concentrations (ppb) at station 63034, Marathon, 1983-85.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above guideline
1983	310	0.9	72	25
1984	329	1.0	71	22
1985	343	1.3	83	52

TABLE 14. Average annual dustfall (g/m²/30 d), Red Rock, 1980-1985.

Station[a]	1980-82		1983		1984		1985	
	Total	Saltcake	Total	Saltcake	Total	Saltcake	Total	Saltcake
63080	9.2	2.0	5.9	0.9	9.0	0.9	6.8	1.3
63081	5.6	1.1	4.3	0.4	5.9	0.5	4.5	0.7
63082	12.6	5.4	6.0	1.6	7.0	0.8	4.9	1.1
63083	3.1	0.8	2.0	0.2	2.1	0.2	3.0	0.4
Average	12.6	2.3	4.6	0.8	6.0	0.6	4.8	0.9

[a]See Figure 9.

[b]Values exceeding annual objective of 4.6 g/m²/30 d are underlined.

TABLE 15. Summary of TRS concentrations (ppb) at station 63084, Red Rock, 1982-85.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above guideline
1982	292	5.0	339	317
1983	300	1.8	156	98
1984	365	1.3	111	23
1985	362	2.0	104	117

TABLE 16. Average annual sulphation rates (mg/SO_3/100 cm^2/d), Terrace Bay, 1982-1985.

Station	Location	1982	1983	1984	1985
63090	St. Martin School	0.15	0.14	0.08	0.12
63091	Ft. Garry Road	0.10	0.14	0.08	0.14
63092	Terrace Heights Dr.	0.10	0.07	0.06	0.08
63093	Mill Road	0.10	0.08	0.09	0.13
63094	Highway 17, #1	0.10	0.14	0.13	0.13
63095	Highway 17, #2	0.08	0.08	0.06	0.08
63096	Highway 17, #3	0.04	0.06	0.06	0.04
	Averages	0.10	0.10	0.08	0.10

TABLE 17. Summary of TRS concentrations (ppb) at station 63090, Terrace Bay, 1982-85.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above guideline
1982	155	0.6	50	7
1983	333	0.9	102	30
1984	331	1.2	104	38
1985	364	1.4	200	67

TABLE 18. Total dustfall ($g/m^2/30$ d), Thunder Bay, 1985.

Station	Location	Monthly Min	Monthly Max	Annual average
63005	McKellar Hospital	0.8	8.2[a]	3.9
63012	Dawson Court	0.8	9.1	3.6
63019	Main St. Pumping Station	<0.1	9.4	3.3
63021	Mission Island	0.5	3.7	1.9
63022	St. Joseph's Hospital	1.1	8.4	3.9
63026	N. Cumberland Hydro	0.4	6.8	3.1
63040	435 James St. South	0.9	7.1	2.9
63046	Montreal Street	2.0	15.1	5.2
63047	Totem Trailer Court	2.5	14.1	6.7
63052	Thunder Bay Transit	0.6	7.9	3.5

[a]Values exceeding maximum acceptable levels of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 19. Total dustfall (g/m²/30 d) at Totem Trailer Court (station 63047), during winter months from 1978 to 1986.

Year	Nov	Dec	Jan	Feb	Mar	Mean
1978-79	1.5	1.5	2.8	0.1	3.0	1.8
1979-80	6.7	1.8	2.7	4.8	5.2	4.2
1980-81	3.0	2.9	1.8	5.2	4.9	3.6
1981-82	10.1[a]	12.7	8.7	9.8	12.6	10.8
1982-83	17.5	15.1	16.6	16.0	9.8	15.0
1983-84	9.1	6.5	9.9	3.1	6.9	7.1
1984-85	8.8	6.4	3.4	5.2	8.9	6.5
1985-86	3.4	2.5	2.2	6.4	2.8	3.5

[a]Values exceeding maximum acceptable level of 7.0 are underlined.

TABLE 20. Total suspended particulate matter (µg/m³), Thunder Bay, 1985.

Station	Number of samples	Annual geometric mean	Number of samples above 120 µg/m³	Maximum 24-hour value
63005	58	36	nil	84
63012	55	25	nil	80
63022	59	32	nil	91
63040	55	27	nil	80
63046	49	47	1	183[a]
63052	60	40	1	124

[a]Values exceeding the maximum acceptable limit of 120 µg/m³ (24-hour average) or 60 µg/m³ (annual geometric mean) are underlined.

TABLE 21. Summary of sulphur dioxide concentrations (ppm) in Thunder Bay, 1985.

Station	Location	Annual average	Maximum 1-hour average	Maximum 24-hour average
63022	St. Joseph's Hospital	<0.001	0.01	<0.01
63040	435 S. James Street	<0.001	0.04	0.01
63041[a]	Mt. McKay		0.37	0.04
63042[a]	East End		0.05	0.01
63044[a]	James St./Kam River		0.07	0.02
63048[a]	Ford Street		0.10	<0.01
63049[a]	Chippewa Park		0.06	0.03
63050[a]	Paipoonge		0.03	0.01
63051[a]	John Street Landfill		0.08	0.01

[a]Ontario Hydro. 1985-86. Enviromental Quality Compliance Reports, 1985. Technical and Training Services Division.

TABLE 22. Summary of total reduced sulphur concentrations (ppb), staton 63046, Thunder Bay, 1977-1985.

Year	Days of data	Annual average	Maximum 1-hour average	Number of times above guideline
1977	298	1.5	56	17
1978	280	1.9	48	28
1979	218	2.6	58	26
1980	220	2.9	131	90
1981	340	2.8	72	74
1982	299	1.0	36	7
1983	305	0.5	36	3
1984	164	0.6	22	nil
1985	286	0.8	27	nil